TRACTION - SW SUPERVISOR and SW VALIDATION & SIMULATION

**20220928_TRACTION_02**

## Background

As the world of industry 4.0 and the Internet of Things moves into the rail sector more on-line condition based monitoring is being deployed on the trains. The latest controllers are being developed with the capability to host web pages which can be accessed remotely.

## Problem description and goals

The purpose of this project is demonstrating a condition based monitoring solution for the train traction converter. The concept is to have a centralised web page which collects data from a number of end nodes and then makes this available for viewing. The kind of information includes operational status of controllers and contactors, temperatures, voltages, and energy usage in different parts of the system. The work can be split up into parts:

1. Architecture to show how to collect data over the ethernet and then present this data in a web page.

2. How to present the data in the most pedagogic and meaningful way.

3. Demonstrate a proof of concept.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: **Ian Bird** Role: Traction Control SW Architect
Email: ian.bird-radolovic@alstomgroup.com

# Propulsion system digital twin linking test with simulation data

## Alstom Västerås / Traction Systems - 20211108_TRACTION_02

### Background

The first step in the design of an electric railway propulsion system for a given application is to define the performance by means simulations. The simulations use physics-based models to determine voltages, currents and temperatures in the various components of the system. In addition to the operational data, key component parameters are also fed into the simulation. These parameters are usually the type or maximum/minimum values for each component in question. When the actual system is built it normally undergoes type testing in a lab environment and compared to the simulations. However, the individual characteristics of the installed components are not necessarily the same as the typical values. This deviation accounts for some of the differences in simulated vs tested equipment. When entering series production and delivery the variance is even more evident. A digital shadow or twin could therefore be a means to quantify the variance.

### Problem description and goals

The thesis project will focus on developing a digital twin for part of the propulsion system, e.g. the converter:

1. General study of electric traction systems
2. Study of Alstom's performance simulation tools and models
3. State of the art literature study on digital twin approaches for electric propulsion systems
4. Develop a digital twin for the selected part of the propulsion system
5. Prepare training data and evaluate digital twin
6. Analysis, conclusions and reporting

Prerequisites: Background in electrical power engineering, power electronics and electric machines combined with data science and modelling. Good analytical skills and systems thinking mindset.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

### Is Swedish a language requirement?

Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

### Possibility to work from our office

Yes:☒

No:☐

**Contact person**

Name: **Ganesh Chandramouli** Role: Head of Innovation
Email: ganesh.chandramouli@alstomgroup.com

# Propulsion performance optimization by increased utilization of SiC MOSFETs

## Alstom Västerås / Traction Systems - 20211108_TRACTION_03

### Background

The advent of Wide Band Gap power semiconductors, especially Silicon Carbide MOSFETs, has a significant impact in creating more compact, low weight and energy efficient railway electric propulsion systems. One parameter that has not been investigated very deeply is how the theoretically increased Safe Operating Area of these devices relative to their rated current can be used to generate further system level benefits.

### Problem description and goals

The thesis project will focus on studying the impact on system level performance of higher SiC MOSFET currents and comprise the following key tasks:

1. Study of electric traction system design
2. State of the art literature study on SiC power semiconductor applications
3. Training in Alstom performance simulation tools and familiarization with Alstom's latest product range
4. Survey of optimization strategies with SiC devices
5. Definition of simulation cases
6. Performance simulations
7. Analysis, conclusions and reporting

Prerequisites: Background in electrical power engineering, power electronics and electric machines. Good analytical skills and systems thinking mindset.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

### Is Swedish a language requirement?

Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

### Possibility to work from our office

Yes:☒
No:☐

**Contact person**
Name: **Ganesh Chandramouli** Role: Head of Innovation
Email: ganesh.chandramouli@alstomgroup.com

**Motor Cooling Optimisation**

## Alstom Västerås / Drives - 20220928_DRIVES_01

### Background

What can railway traction motors learn from the emerging electromobility sector in terms of performance density?

### Problem description and goals

- Literature review – what can railway traction motors learn from the emerging electromobility sector in terms of performance density?
- Case studies to be completed using 2D finite element modelling and optimisation techniques:
    - Identification of an optimum cooling channel configuration.
    - Assessing the impact of manufacturing tolerances on cooling channel efficiency.
    - Design optimisation of cooling channels for stress and heat transfer.
    - The impact of moving the cooling channels to the stator stack. .

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: **Richard Russell-Johnson** Role: Traction Motor Structural Engineer
Email: richard.russell-johnson@alstomgroup.com

# Trends from E-Mobility applied on railway Traction Motor applications

## Alstom Västerås / Drives - 20220928_DRIVES_02

### Background

he world of electric machines gets very much attention as electric machines are essential in order to electify the transport sector. The global trend is to implement electrical cars, buses, trucks, aircrafts, boats etc, where all relies on performance dense electric motors.

### Problem description and goals

The task of this thesis can be to:- Understand current state of railway traction motors - Pinpoint critical development areas required for success of traction motors in E-Mobility (E-aircrafts, E-trucks, E-cars etc)- Identify areas of improvements for railway traction motors, considering research applicable from the other E-mobility areas. Define how to verify in Railway application ?

Depending on profile of candidate, extended analysis can be performed in the candidate's preferred field

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: **Tobias Nässén** Role: Traction Motor R&D Program Manager
Email: tobias.nassen@alstomgroup.com

# Cooling enhancement technologies for enclosed traction motors

## Alstom Västerås / Drives - 20220928_DRIVES_03

### Background

Totally enclosed traction motors normally have difficulties to dissipate heat due to poor cooling. To improve performance of such motors, it is essential to have superior cooling and superior heat transfer within the motor.

### Problem description and goals

The task of this thesis can be to:

- General study of totally enclosed traction motors for railway
- Create an understanding of loss distribution inside the motor and associated cooling paths where heat is dissipated
- Perform study on heat transfer mechanisms
- Identify and evaluate cooling enhancement technologies for enclosed traction motors
- Analysis, conclusions, reporting

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: **Tobias Nässén** Role: Traction Motor R&D Program Manager
Email: tobias.nassen@alstomgroup.com

# Design for recycling of traction motor

## Alstom Västerås / Drives - 20220928_DRIVES_04

### Background

A critical topic for traction motors is that some of the alloys used in the motor are quite costly since the world market demand is very high and there are a limited numbers of suppliers of the alloys..

### Problem description and goals

The task of this thesis can be to investigate:

- How are motors in general recycled today, both within the railway industry and other areas as the automotive industry
- What alloys are recycled today and to what level can they be recycled
- How big is the difference in cost between recycled and virgin alloys
- Are there any alloys that are more or less suitable for recycling
- Are there any quality issues to use recycled alloys?

The thesis should also cover a proposal how recycling should be used in an optimal way for a Alstom Traction motor.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: Karl-Gustav von Der Burg Role: Product Manager, Drives
Email: karl-gustav.von-der-burg@alstomgroup.com

# Digitalisation in Modern SW Delivery Project Processes

**Alstom Västerås / Traction Control - 20220928_TRACTION_01**

## Background

In a fast moving and competitive market there is a never ending pressure to deliver SW projects to customers faster, but still maintain the highest quality and staying within the budget constraints. Our experience is that many projects can be delayed or go over budget due to the fact that the delivery process does not run a smoothly as first predicted. We would like to understand more detail about why this is occurring and to suggest ways to avoid or mitigate this using modern digitalisation techniques.

## Problem description and goals

The purpose of this work is to investigate the process for delivering Propulsion SW to Alstom trains , identify where the bottlenecks are and to suggest where digitalisation could be used to optimise or improve the processes. Examples might include automation of time intensive tasks, better sharing of information or information management, simulation/digital twins to left shift design work, using AI to replace some activities which are being done by people today etc. This work will provide an introduction into the SW delivery process for a large industrial project. It will introduce the student into the 'V' model of working (Requirements to design, to testing, to verification and validation). These kinds of processes can be found in almost all industrial settings and so it will provide a valuable and transferable overview of how SW is developed. The work can be split up into 3 parts:

1.Interview engineers to build up a picture of the SW delivery process and to identify pain points and bottlenecks.

2. Review and suggest different digitisation solutions which can be applied to streamline the process and remove bottlenecks and pain points.

3. Demonstrate one or more solutions in a proof of concept

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒

No:☐

**Contact person**

Name: **Ian Bird** Role: Traction Control SW Architect
Email: ian.bird-radolovic@alstomgroup.com

# SW SUPERVISOR and SW VALIDATION & SIMULATION

## Alstom Västerås / Traction Control - 20220928_TRACTION_02

### Background

As the world of industry 4.0 and the Internet of Things moves into the rail sector more on-line condition based monitoring is being deployed on the trains. The latest controllers are being developed with the capability to host web pages which can be accessed remotely.

### Problem description and goals

The purpose of this project is demonstrating a condition based monitoring solution for the train traction converter. The concept is to have a centralised web page which collects data from a number of end nodes and then makes this available for viewing. The kind of information includes operational status of controllers and contactors, temperatures, voltages, and energy usage in different parts of the system. The work can be split up into parts:

1. Architecture to show how to collect data over the ethernet and then present this data in a web page.

2. How to present the data in the most pedagogic and meaningful way.

3. Demonstrate a proof of concept.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

### Is Swedish a language requirement?

Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

### Possibility to work from our office

Yes:☒
No:☐

### Contact person

Name: **Ian Bird** Role: Traction Control SW Architect
Email: ian.bird-radolovic@alstomgroup.com

# Examensarbete – teknisk utredning om detektering av moderna signallampor

**Alstom Stockholm**

**Background**
När lågenergilampor gör inträde inom järnvägssignallering, så måste signalsystemen anpassas. Problemen måste kartläggas I förväg. Förbättringar måste föreslås.

**Problem description and goals**
Glödtrådsbaserade signallampor dominerar fortfarande inom järnvägen. Att gå över till modern lampteknik kommer innebära visa utmaningar. Den s.k. ATP kodaren som tillverkas och säljs av Alstom sen många år tillbaka gör effektmätningar på signallampor och är så anpassad till uppgiften att den inte kan hantera moderna lampor. Detta behöver lösas.
Arbetet är teoretiskt och praktiskt.
Se även arbetsinstruktion 1DOC-1090352

**Type of degree project (can be both)**
Master (20 weeks):☐
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Name: Fredrik Täng Role:Produktägare
Email: fredrik.tang@alstomgroup.com

# Evaluation of open-source hypervisors for safety critical railway applications

## ALSTOM

### Background

Leading societies to a low carbon future, Alstom develops and markets mobility solutions that provide the sustainable foundations for the future of transportation. Our product portfolio ranges from high-speed trains, metros, monorail, and trams to integrated systems, customised services, infrastructure, signalling and digital mobility solutions. Joining us means joining a caring, responsible, and innovative company where more than 70,000 people lead the way to greener and smarter mobility, worldwide.

With the advent of Systems-on-Chip for functional safety applications and novel levels of multi-core integration, safety products are getting more compact and more energy efficient. One way of achieving high levels of performance and utilization on such a system is to use hypervisors. A hypervisor partitions the hardware resources (e.g., CPU, RAM, peripherals) into several separate virtual machines that can be used independently.

However, in the safety applications, the hypervisor not only itself should operate in a safe and secure way but should also maintain the isolation between the virtual machines, so that one faulty machine does not jeopardize the operation of others.

The focus of this master thesis is to study and evaluate today's open-source hypervisors and railway standards such as EN 50128 and IEC 61508-3. With reading the standards the candidate(s) shall devise a metric to evaluate and measure the gaps of available hypervisors to the requirements of safety applications in the railway domain. Also, the candidate(s) shall specify techniques and methods that need to be added to the top-rated hypervisor from the evaluation to meet the requirements for the highest level of safety of EN 50128.

The candidate shall have a good knowledge and understanding of the following areas:

1. Computer Architecture.
2. Realtime systems and Operating Systems
3. Software programming

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☐ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒

No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Sina Borrami Hardware Designer
sina.borrami@alstomgroup.com

Jonas Melchert Software Engineer
jonas.melchert@alstomgroup.com

# EMI immune probe design exploration and implementation

## ALSTOM

### Background

Leading societies to a low carbon future, Alstom develops and markets mobility solutions that provide the sustainable foundations for the future of transportation. Our product portfolio ranges from high-speed trains, metros, monorail, and trams to integrated systems, customised services, infrastructure, signalling and digital mobility solutions. Joining us means joining a caring, responsible, and innovative company where more than 70,000 people lead the way to greener and smarter mobility, worldwide.

Balise is a wireless transponder used as a beacon in many train signal systems in the world, Among them, the European system: ERTMS. This system has been designed for optimal performance and availability.  Balise is exposed to a harsh environment, where there're different types of debris, e.g. metal objects, iron ore, clear water, salt water. These debris together with temperature cycling would have impact on Balise's uplink characteristics.

Therefore, during the design and development, the Balise transmission performance needs to be measured and evaluated. However, the traditional measurement tool suffers from lab EM disturbance.

### Problem description and goals

The focus of this master thesis is the architecture design and implementation of an EMI immune measurement tool, to measure and characterise the transmission flux of a Balise or Antenna, then transfer the signal via optical fibre to PC for signal processing.

Within the required responsibilities the candidate should:

- Based on system level specifications, establish block level specifications, identify key-problem and propose/analyse different architectures that would meet specifications.
- Based on block level specifications, select and justify the components which will together build up the measurement tool.
- Compare and analyse the measurement result with DSP between the traditional measurement probe and the EM immune measurement probe.

### Qualification:

For this thesis work we would like to have students who are in the study of M.Sc. in Electronics, Photonics, or Physics with good theoretical knowledge and proven practical experience in the following areas:

Lab activities
Electronics design
Signal processing
Fluent in English
Self-motivated

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☐ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Anders Rehn Hardware Designer
anders.rehn@alstomgroup.com

Thomas Eriksson Product Designer
thomas.eriksson@alstomgroup.com

# Metallic objects CAD design for Big Metal Masses Research

## ALSTOM

### Background

Leading societies to a low carbon future, Alstom develops and markets mobility solutions that provide the sustainable foundations for the future of transportation. Our product portfolio ranges from high-speed trains, metros, monorail, and trams to integrated systems, customised services, infrastructure, signalling and digital mobility solutions. Joining us means joining a caring, responsible, and innovative company where more than 70,000 people lead the way to greener and smarter mobility, worldwide.

Both Balises and onboard system suffers from metallic objects on track. Some of them would have slight impact on the transmission performance, while some of them would trigger alarms for onboard system.

Measurements with big metal masses have been performed in lab with a reference loop which is a lab equipment. It would be interesting and beneficial to do a research, to see the feasibility of characterising with the antenna which is already mounted on the train.  In this way, the antenna can be used on a test train or maintenance vehicle for preventive purposes.

### Problem description and goals

The feasibility study has two parts, the first step is to investigate different metallic object that would appear on track and that would have impact on the onboard system(e.g. cause sporadic antenna test failure). The second step is the feasibility study of BMM characterisation with the existing antenna on the train.

The scope of this thesis will focus on the first part above. Within the required responsibilities the candidate should:

- Perform a technological survey of the metallic objects that might be placed on track and might appear on track.
- Perform a research for metallic objects which wouldn't appear on real track, but would provide informative data for the feasibility study of the characterization with train antenna.
- Based on the study above, do design calculations and CAD design of the metallic objects(DfM)

### Qualification:

For this thesis work we would like to have students who are in the study of M.Sc. in Mechanical Engineering with good theoretical knowledge and proven practical experience in the following areas:

Mechanical CAD design
Design for manufacturing
Fluent in English
Self-motivated

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☐ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Anders Rehn Hardware Designer
anders.rehn@alstomgroup.com

Thomas Eriksson Product Designer
thomas.eriksson@alstomgroup.com

# Master Thesis Proposals: Certification and Authorisation

## Contents

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• mobility by nature •

## Proposal 1: Relation Between Short-Term Product Development and Long-Term Industry Goals

**Updates in legal texts and standards. Cycles within cycles for products. CENELEC. Requirements. Agility.**

### Background

Alstom is the largest signalling system supplier for the Swedish railway market, thus being well integrated into the development and future of Swedish railway. Alstom is also a global leader within railway vehicles and trackside signalling systems.

The EU works to support the railway industry through promoting technical interoperability, which yields the possibility to cross country borders in a unified manner, as well as legal compatibility, where a vehicle authorised in one country is automatically authorised in the other EU countries. Hence, the product and system development, as well as requirements fulfilment, must be in line with the European legislation, current needs in the Swedish railway network, and needs of the future. At the same time, the product development also occurs in shorter cycles where new hardware and software are developed and commissioned continuously to meet the short-term needs of the market. This way, the international market for signalling systems is governed by both shorter and longer product development cycles.

### Problem Description

One obstacle for uniting the short and long cycles is that development and safety evidence for railway systems use standards developed by CENELEC (Comité Européen de Normalisation Electrotechnique), which govern the system lifecycle and safety work. The standards follow the V cycle model where each phase is only visited once and are not adjusted for an agile way of working. In addition, the railway industry, despite now being a modern and highly technological field, contains a large amount of conservatism in the mindset around requirements updates, error corrections and product availability for the market.

We hope that you want to support Alstom's work in integrating an agile process with applicable standards and legislation.

### Central Input Documents

The most important input documents are listed here. Please note that the first four documents are only partially applicable. They will not be relevant in their entirety.

1. EN 50126: The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
2. EN 50128: Communication, signalling and processing systems – Software for railway control and protection systems
3. EN 50129: Communication, signalling and processing systems – Safety related electronic systems for signalling
4. (EU) 2016/919: Technical specification for interoperability relating to the "control-command and signalling" subsystems of the rail system in the European Union
5. (EU) 2013/402: Common safety method for risk evaluation and assessment (CSM-RA)
6. Generic Application Safety Case for CBSS_BV_L2
7. Conformity Verification Report for CBSS_BV_L2

### Project Description

The project will be carried out in close collaboration with safety and authorisation engineers at Alstom. The daily work consists of reading, question framing, discussions, and independent information gathering and regular documentation. Part of the work will be carried out in Alstom's offices in Liljeholmen, but can also be done in other locations, such as at KTH or at home, depending on preferences. The work will be to gather information, summarise key take-aways and main ideas from agile concepts and match these with traditional waterfall product development methods and communicate these findings with engineers

across the company. The work will initially run in parallel with ongoing projects but will eventually merge in order to find efficient ways of integrating agility and pragmatism into the daily work.

The project will give a good insight into the modernising railway business with related international standards and EU legislation. It reflects much of the work carried out by engineers at Alstom when methods and ways of working are developed. However, this project will carry a stronger academic focus on method development, framing questions and reporting. The focus of the method development is how to handle a combination of agile development with processes and standards developed in a waterfall context.

**Deliverables**

- The work will result in a report containing background, thesis questions, analyses, and (partial) results concerning how product development can be adjusted, in the short and long perspective, to suit current and future requirements and legislation. The report can be developed according to proposals from KTH to completely correspond to the master's thesis.
- The work will result in a shorter findings summary (about two pages) with an overview of the most important questions and results of the thesis work.
- The work will also result in a presentation which can be delivered in front of relevant personnel at Alstom. This presentation can (but does not have to) correspond to the thesis presentation at KTH.

**What are the key takeaways from this thesis project?**

- This thesis project will lead to a good insight into the railway business and working for a private company that is in close contact with national and international authorities.
- The project will give insight into both traditional and agile product development strategies, both for the railway industry but also in general. The emphasis will be on software development.
- The project will include the application of Swedish and EU legislation and will be in a cross-disciplinary territory containing technology, law, organisation, infrastructure, politics, and economy.
- The thesis work will lead to direct contacts and networking with actors in the field.

Contact persons:
Måns Elenius Mans.elenius@alstomgroup.com
Riccard Andersson Riccard.andersson@alstomgroup.com

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## Proposal 2: Approvals Processes Within Trackside with Regards to the Fourth Railway Package, e.g. TSFS2022:47

**Swedish knowledge is a large bonus as important law texts are in Swedish**
**Implementation and effect of law texts in the authorisation of railways. Interface between the central actors in the industry, the manufacturers, the National Safety Agency (Transportstyrelsen) and the national Infrastructure Manager (Trafikverket). The effects of the law changes on manufacturer's client projects.**

### Background

Alstom is the largest signalling system supplier for the Swedish railway market, thus being well integrated into the development and future of Swedish railway. Alstom is also a global leader within railway vehicles and trackside signalling systems.

The railway legislation in Sweden has just gone through a major rewriting, this as an effect of the implementation of new legislation on EU level (commonly called the 4th railway package). The authorisation processes for the Swedish railway infrastructure have always been dominated by the processes defined by Trafikverket. The implementation of EU laws has not had notable effect on how the authorisations have been performed in actuality. It is now indicated that this is about to change and there is uncertainty on how the new processes will look and what impact they will have on the ongoing and future railway projects. Focus will be on signalling system installations.

### Central Input Documents

The most important input documents are listed here. Please note that the first three documents are only partially applicable. They will not be relevant in their entirety.

1. (EU) 2016/797, DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the European Union
2. (EU) 2016/798, DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety
3. 2022:366, Järnvägstekniklagen (*in Swedish*)
4. TSFS 2010:116 Transportstyrelsens föreskrifter om godkännande av delsystem för järnväg (*in Swedish*)
5. TSFS 2022:47 Transportstyrelsens föreskrifter om ansökan om godkännande av fasta installationer på den svenska delen av Europeiska unionens järnvägssystem (*in Swedish*)
6. (EU) 2013/402: Common safety method for risk evaluation and assessment (CSM-RA)
7. TDOK 2014:0488: Teknisk säkerhetsstyrning signal, Arbete med signalanläggningar (*in Swedish*)
8. Alstom project documents used to achieve authorisations

### Project Description

The project will be carried out in close collaboration with safety and approvals engineers at Alstom. The daily work consists of reading, question framing, discussions, and independent information gathering and regular documentation. Part of the work will be carried out in Alstom's offices in Liljeholmen, but can also be done in other locations, such as at KTH or at home, depending on preferences. The project will give a good insight into the modernising railway business with related international standards and EU legislation. It reflects much of the work carried out by engineers at Alstom when methods and ways of working are developed. However, this project will carry a stronger academic focus on method development, framing questions and reporting. The focus of the work is to describe what is happening related to authorisations for fixed Swedish railway installations, propose venues for further work and, if time permits, propose ways of working to optimise the processes for involved parties.

### Deliverables

- The work will result in a report containing background, thesis questions, analyses, and (partial) results concerning the effects of the ongoing changes in the Swedish fixed railway installation

authorisations regime. Focus will be on signalling installations. The report can be developed according to proposals from KTH to completely correspond to the master's thesis.
- The work will result in a shorter findings summary (about two pages) with an overview of the most important questions and results of the thesis work.
- The work will also result in a presentation which can be delivered in front of relevant personnel at Alstom. This presentation can (but does not have to) correspond to the thesis presentation at KTH.

**What are the key takeaways from this thesis project?**

- This thesis project will lead to a good insight into the railway business and working for a private company that is in close contact with national and international authorities.
- The project will include the application of Swedish and EU legislation and will be in a cross-disciplinary territory containing technology, law, organisation, infrastructure, politics, and economy.
- The thesis work will lead to direct contacts and networking with actors in the field.

Contact persons:
Måns Elenius Mans.elenius@alstomgroup.com
Riccard Andersson Riccard.andersson@alstomgroup.com

ALSTOM
• mobility by nature •

## Proposal 3: The Role and Development of the Hazard Log within Trackside Systems and Projects

**Legal texts and standards. Lifecycle development. Risk identification and analysis. CENELEC. DOORS.**

### Background

Alstom is the largest signalling system supplier for the Swedish railway market, thus being well integrated into the development and future of Swedish railway. Alstom is also a global leader within railway vehicles and trackside signalling systems.

The product and system development as well as requirements fulfilment within the railway industry in Sweden must be in line with European legislation, current needs in the Swedish railway network, and needs of the future. With the introduction of the fourth railway package (4RP) in the European Union and corresponding cascading changes in the Swedish legislation, the need for an up-to-date, legally compliant, and applicable hazard log, as the foundation of the safety and certification work within development and customer projects, is emphasised.

### Problem Description

Historically, the hazard log has been updated and applied on an as-needed basis, which has caused its applicability and usability to vary and its consistency for management of hazards to sometimes be outdated. Now and in the future, however, an update and refreshment of the hazard log to be tailored for the systems and products in place and targeting the daily safety and certification work is imminent.

We hope that you want to support Alstom's work in analysing, updating, managing and integrating the hazard log to be applicable for current and future system needs. Ideally, this is managed in the requirement management tool DOORS, tying to the company processes.

### Central Input Documents

The most important input documents are listed here. Please note that the first three documents are only partially applicable. They will not be relevant in their entirety.

1. EN 50126: The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
2. EN 50128: Communication, signalling and processing systems – Software for railway control and protection systems
3. EN 50129: Communication, signalling and processing systems – Safety related electronic systems for signalling
4. (EU) 2013/402: Common safety method for risk evaluation and assessment (CSM-RA)
5. Generic Application Safety Case for CBSS_BV_L2
6. Conformity Verification Report for CBSS_BV_L2
7. Scientific papers or books on risk and hazard management

### Project Description

The project will be carried out in close collaboration with safety and authorisation engineers at Alstom. The daily work consists of reading, question framing, discussions, and independent information gathering and regular documentation. Part of the work will be carried out in Alstom's offices in Liljeholmen, but can also be done in other locations, such as at KTH or at home, depending on preferences. The work will be to gather information, summarise key take-aways and main ideas from best practices and concepts for risk management and match these with the existing product development. A key point is to communicate these findings with engineers across the company and apply and implement the findings into the existing hazard log for trackside systems within Alstom. The work will initially run in parallel with ongoing projects but will eventually merge in order to find efficient ways of integrating risk management concepts and pragmatism into the daily work.

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The project will give a good insight into the modernising railway business with related international standards and EU legislation. It will also include training and active participation in database development within the requirements management tool DOORS. It reflects much of the work carried out by engineers at Alstom when methods and ways of working are developed. However, this project will carry a stronger academic focus on method development, framing questions and reporting. The focus of the method development is how to handle a combination of modern risk management methods, agile development with processes and standards developed in a historic context.

**Deliverables**

- The work will result in a report containing background, thesis questions, analyses, and (partial) results concerning how product development can be adjusted, in the short and long perspective, to suit current and future requirements and legislation. The report can be developed according to proposals from KTH to completely correspond to the master's thesis.
- The work will result in a shorter findings summary (about two pages) with an overview of the most important questions and results of the thesis work.
- The work will also result in a presentation which can be delivered in front of relevant personnel at Alstom. This presentation can (but does not have to) correspond to the thesis presentation at KTH.

**What are the key takeaways from this thesis project?**

- This thesis project will lead to a good insight into the railway business and working for a private company that is in close contact with national and international authorities.
- The project will give insight into both traditional and agile product development strategies, both for the railway industry but also in general. The emphasis will be on software development.
- The project will include the application of Swedish and EU legislation and will be in a cross-disciplinary territory containing technology, law, organisation, infrastructure, politics, and economy.
- The thesis work will lead to direct contacts and networking with actors in the field.

Contact persons:
Måns Elenius Mans.elenius@alstomgroup.com
Riccard Andersson Riccard.andersson@alstomgroup.com

# Master's Thesis:

## Fault slip through analysis

## Background

Because we are developing high availability safety critical applications it is important to have good feedback mechanisms to know which type of defects that slip through our current testing efforts. Today we do not measure this on a regular basis. Therefore, it would be a good initiative to identify which and how many of our known defects that slip through our current test activities of component testing, sub-system testing, system testing and to the customer.

## Objective

To analyze and measure which defects that slip through our current test activities and to the customer.

The project will consist of the following tasks:

1. Do a defect analysis of found defects in component testing. Also identify which defects that are found later that should have been able to find in component testing.
2. Do a defect analysis in the same way on sub-system level, i.e. to identify found categories of defects and which defects that slip through to a later phase or to the customer.
3. Do a defect analysis on system level to identify which types of defects are found and which defects slips through to the customer.
4. Make a conclusion of all defects found by the customer to identify where they should have been found earlier.

## Application

Prerequisites: Good analytical ability and complex system knowledge. Knowledge in software test techniques and root cause analysis is also valuable.

For more information, contact

Anders Claesson
Anders.claesson@rail.bombardier.com
073-433 1815

# Thesis project – Safe Runtime Configuration Data Entry

## Background

The INTERFLO150 solution is a computer based train control system used in industrial applications. The system interfaces a number of external systems in the process of loading and unloading material. As part of this the configuration of the train requires detailed information about the vehicles within the train including, but not limited to, vehicle length, vehicle identities, brake properties, material capacity etc. Some of these properties are critical to maintaining the safety of the system. Each vehicle in the system is configured with the type of vehicle, identity etc.

Today there is no process in which the customer can directly add or remove vehicles or change properties of the vehicle types.

## Scope of the work

The scope of the thesis work is to create a proof of concept a vehicle database where:

- a user can add, remove or change templates for vehicle types,
- a user can add, remove or change entries,
- a user can sign one or more entries,
- a second user (verifier) can sign that the entries have been verified,
- entries can be imported and signed from an existing source,
- the application can load/request entries on demand,
- the application can verify the signature on an entry without having to verify the complete dataset,
- strict guarantees to the application that no entries have been lost or changed after verification,
- the application can implement the verification in safety critical software (no external libraries etc.),
- entries are backup to an on-site or off-site location.

## Key responsibilities

- Create a backend for storing entries
- Investigate techniques for signing entries based on Scope of Work, for example Merkle Tree,
- Create a simple user interface that can add, remove, edit, verify and show entries
- Create a proof of concept program that can retrieve entries using a key and verify individual entries. This shall not rely on external libraries or not allowed operations, such as floating point operations or unrestricted memory allocation.
- Prove that alteration of the data will be detected during verification in the application.
- Create an API or proof of concept script for importing data from an external source where the data is signed after the import is done.
- Investigate how keys used to sign entries could be securely distributed.
- Setup a backup process for the vehicle database.

## Location

The thesis work shall be made in Alstom D&IS division located in Göteborg. The students shall be located in the office in Polhemsplatsen 5 during the major part of the work.

## Contact person

**Anders Palmér**

Alstom
Email: anders.palmer@alstomgroup.com
Mobile: +46 (0)76 877 25 67

# Utvärdering av belysningssystem

## Jernhusen

**Background**
Smarta belysningsstyrningar som integrerar med andra fastighetstekniska system kommer vara en självklarhet i framtiden. Vi på Jenhusen tar gärna hjälp av någon som kan sätta sig in I olika lösningar och gå på djupet gällande funktionalitet, kvalitet, säkerhet, möjlighet till integration etc.

**Problem description, tasks, and goals**
Probemet idag är att olika typer av standarder inte tydligt framgår i leverantörernas helhetslösningar. Vi vill hitta systemlösningar för framtiden och inte en leverantör/product. Målsättningen är att ta fram en "manual" som beskriver olika lösningar med dess styrkor och svagheter.

**Type of degree project (can be both)**
Master (20 weeks):☐
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☐

**Is Swedish a language requirement?**
Yes:☒
No: ☐
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Daniel Larsson Automationsingengör
Daniel.larsson@jernhusen.se

# Assignments in rail traffic

## SL Region Stockholm

**Background**
The assignments for rail traffic are in the following areas: Traffic, Operation and maintenance, Organization and processes, Technology in traffic control and signalling

**Problem description, tasks, and goals**
The purpose of all different master thesis that deal with orientation and choice of technology for systems and working methods for rail traffic is to contribute to and ensure that both asset management and development perspectives are taken into account currently in this moment and in the future.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
HR Team Student about practical things: application, assignment
student@sl.se

Andreas To discuss interest in: different areas, ideas, work performance
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Kristina To discuss interest in: different areas, ideas, work performance
kristina.lovenberg@regionstockholm.se

# Enable digital transformation with RMD innovations in rail.

# RMD – Railway Metrics and Dynamics AB / Omicron Ceti AB

**Background**
Railway Metrics and Dynamics (RMD) develops sensor systems and sells services based on sensor data analysis. Supported by Omicron Ceti AB. Sensors and services are already delivered to rail vehicle owners and operators in Sweden and world-wide. RMD is also commissioned by Swedish infrastructure owner Trafikverket through an innovation tender. The aim is to complement today's infrequent infrastructure inspections by instrumenting trains in traffic with RMD's Performance Measuring Units and using machine learning to improve decision support for infrastructure maintenance. Initial focus on a. Tracks, b. Over-head power-line (OHL)

**Problem description, tasks, and goals**
Problem: How can we enable digital transformation with RMD innovations? Tasks: follow in the steps of our present and new partners: A. Rohan Kulkarni - rkulkarni@kth.se - "Onboard condition monitoring of vehicle-track dynamic interaction using machine learning: Enabling the railway industry's digital transformation". B. William Liu - zhendong@kth.se - "Measures to Enhance the Dynamic Performance of Railway Catenaries,". C. Bastian Schick - bschick@kth.se - "Pantograph-catenary dynamic interaction". Goals: Enable digital transformation with RMD innovations.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☐ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Peter Melander / Kenneth Wrife Role
peter.melander@railwaymetrics.com / ken@omicron.se

# Automatic Classification of Vehicle Damage Records

## SJ AB

### Background

SJ operates a large fleet of trains. Maintenance of this fleet falls under two maintenance categories: preventive maintenance (förebyggande underhåll, FU) and corrective maintenance (avhjälpande underhåll, AU). FU is carried out either based on kilometers or hours and is described in our maintenance plan, specific to each vehicle type. Corrective maintenance is performed as needed.

The need for AU arises when someone, often a workshop, onboard personnel, driver, or depot, detects damage to the vehicle and reports it through one of our reporting channels. These damages, unless safety-critical, which have their own procedure, are then forwarded to the workshop for repairs.

It is through reviewing and recording these AU reports that vehicle engineers in the vehicle division discover new types of damage, track trends, and monitor which subsystems are beginning to wear out or require anything from specific interventions to entirely new FU approaches.

AU reports provide the opportunity to enter all necessary information about the damage, such as the vehicle "carriage," the timing, the component involved, and the action taken to address the damage.

### Problem description, tasks, and goals.

Since AU reports are created by individuals with varying technical knowledge, interest, and time constraints, there is much room for improvement in the quality of these entries. Often, they are misclassified, misspelled, and formatted in a generally messy manner. This makes it difficult to categorize and track the trends we genuinely want and should be able to follow. There is a lot of noise in the data, resulting in the need for significant technical expertise in the system for follow-up and trend analysis. This makes the data ambiguous and often hard to access.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

# Develop a door computer for train coaches

## SJ AB

**Background**
As vehicles are getting older the technology used is slowly outdated and spare parts are not any longer possible to buy or produce. An example of this is the PLC computer containing all the intelligence and functionality for steering of the doors in the passenger coaches. SJ needs a new computer to be able to keep the coaches in traffic in the future.

**Problem description, tasks, and goals**
Pre-study: Analyse the current computer technology and the functionalities that it provides. Technical solution: Find an existing PLC computer that is railway compatible according to all regulations with safety integrity level 3 or above. Write code for the new PLC computer that fulfils today's railway requirements and adds the possibility to communicate with new train monitoring system for passenger coaches. The aim of monitoring the signals is to increase reliability, availability, and maintainability of the door systems. The doors are crucial for passenger safety and therefor much effort must be put on safety matters. A new computer with code must be able to replace the old computer to full extent. Final report: A written technical report and a presentation of the findings to involved roles and functions at SJ. The report should describe the technical solution and a recommendation on how to implement it.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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hogskolegruppen@sj.se

# Enhancing Efficiency in Vehicle Damage and Spare Parts Management at SJ

## SJ AB

**Background**
SJ possesses an extensive and multifaceted fleet of trains spanning various ages and conditions, forming a large and diverse collection. This diversity in the train inventory gives rise to an even more multifaceted and intricate challenge when it comes to managing spare parts and damages. The variation, in turn, places high demands on workshop inventory management and the precision of vehicle documentation. With such a comprehensive and vast array of train models covering a wide span of time, a sophisticated and well-informed strategy is required to maintain efficient operations by ensuring that the right spare parts are available at the right time and that crucial information about each vehicle is meticulously documented and easily accessible.

**Problem description, tasks, and goals**
Currently, identifying which component one is looking at, where it is located, and whether it is available on the spare parts shelf involves consulting manuals and sifting through lengthy and outdated tables with numbers and names. The goal is to develop improved methodologies and/or tools that enable rapid and accurate identification of damaged components, their part numbers, and their exact location on board the train. This can be achieved by either enhancing the reporting process or optimizing inventory management. By doing so, the aim is to enhance efficiency and precision in spare parts and damage management, ultimately leading to smoother and more reliable train fleet operations.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Joel Elinder Vehicle Engineer X2000
hogskolegruppen@sj.se

# Automation in timetable construction

## Sweco Sverige AB – Tågtrafik & Logistik (Railway traffic & Logistics)

**Background**
The railway is a complex system, and we are facing a paradigm shift in the industry where automation and artificial intelligence are creating new opportunities. Today, timetables are manually constructed and evaluated in a lengthy process. The train schedule, which takes months to produce, then determines the traffic for one year at a time. If the process is streamlined, timetable and train traffic planning can become more flexible, enabling more capacity to handle disruptions and changes that may arise.

**Problem description and goals**
The thesis proposal is about using data on infrastructure and vehicle performance to create a timetable that maximises resources. This can be achieved by using algorithms and artificial intelligence to automate parts or all of the timetable construction process. A case study of a railway line can be used to investigate this, and the output can be a generated timetable for further analysis on how it can be optimally used to transport more passengers or goods.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Stefan Bojander
stefan.bojander@sweco.se
Group manager Railway traffic & Logistics

# Ballast cleaning for the Swedish railways

## SWECO – Transport, Railway

### Background

SWECO is the leading architecture and technical consultant company in Europe with 20 000 employees throughout the continent. Within the railway sector, we have experts in all technical disciplines, e.g. track technology and design, signalling systems and traffic control, electric power system, rolling stock and railway capacity. This degree project proposal is set in the context of the maintenance of the railway track system, with a focus on the ballast cleaning process. Ballast cleaning is the most used maintenance approach to improve the capabilities of the ballast layer. For this project, you need to have a background in railway track technology and/or geotechnical engineering.

### Problem description and goals

The ballast layer is an essential part of the ballasted railway track. It is the upper layer in the railway foundation which should withstand the vertical, lateral and longitudinal forces that occurs with train movements. At the same time, it should also be able to let through the surface water. However, after numerous amounts of cyclic loading from the railway traffic, the ballast layer is degraded by wear and breakage of the particles, as well as from the environment around it, which reduces the desired effects. The typical maintenance approach for improving the ballast quality is to clean the ballast, where the fouled particles are sieved and deposed. Beforehand, site visits are made, and particle degradation curves are often extracted at even distances, to have an idea of the in-situ quality and, furthermore, the need of supplementary ballast, the need of storage areas, and estimated production pace. However, these are only estimations made with the known data, and the real outcome often differ greatly. One part of this project is to do an analysis of the latest research of the topic and what is made in other countries regarding keeping track of the ballast quality. Another part is to dig deep into the factors involved in the process of mass handling for ballast cleaning. Possible outcomes are recommendations on how to improve the mass handling process of ballast cleaning, with a focus of mass estimation, and recommendations of methods to keep track of the ballast quality at the Swedish railways.

### Type of degree project (can be both)

Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

### Language for the thesis

Swedish:☒ and/or English:☒

### Is Swedish a language requirement?

Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

### Possibility to work from our office

Yes:☒
No:☒
Depending on the outline of the thesis, it can be needed to work partly at KTH.

### Contact person

Karl Norberg Railway engineer/Investigator
karl.norberg@sweco.se

**Improvement of Railway Vehicle Maintenance Planning with the Use of AI**

# SWECO – Rolling Stock, Railway

## Background

SWECO is the leading architecture and technical consultant company in Europe with 20 000 employees throughout the continent. Within the railway sector, we have experts in all technical disciplines, e.g., track technology and design, signalling systems and traffic control, electric power system, rolling stock and railway capacity.

## Problem description and goals

Develop a conceptual approach to applying artificial intelligence (AI) to analyze data from condition-based maintenance of railway vehicles, with the aim of optimizing and improving maintenance planning for rail operators.

Parts:

1. Literature review: ** - Review of existing literature and research related to condition-based maintenance, rail vehicles, and the use of AI in maintenance planning.

2. Interviews

1. With rail operators regarding their current use of data collection and analysis for condition based maintenance

2. With representatives from other industries where AI is already being utilized for maintenance purposes.

3. Data sources and Data availability: ** - Identify potential data sources and data collection systems that can be used to collect relevant data on the condition and maintenance history of railway vehicles.

4. AI Models and Techniques: ** - Explore different AI models and techniques that can be applied to the collected data to detect patterns, predict failures, and optimize maintenance planning.

5. Model evaluation: ** - Evaluate the potential AI models through simulations and prototypes to assess their effectiveness and accuracy in predicting maintenance needs.

6. Conceptual Strategy Development: ** - Develop a conceptual strategy describing how AI technology can be integrated into railway operators' existing maintenance processes. The strategy should include methods to monitor, update, and adapt AI models over time.

7. Implementation guidance: ** - Create an implementation guidance that describes step-by-step how rail operators can start using the proposed strategy and integrate AI into their maintenance planning.

Objectives for the degree project:**- Identify how AI technology can be used to improve the efficiency and reliability of maintenance planning for railway vehicles.- Develop a conceptual strategy that can be used as a basis for integrating AI into practice for railway operators.- Evaluate the potential benefits and challenges of implementing AI in railway vehicle maintenance.- Contribute to the knowledge base in the field of condition-based maintenance and AI applications in railway industry.

This thesis will explore the possibilities that AI technology offers to transform and streamline maintenance planning for railway vehicles, and it does not require advanced programming knowledge, but rather an ability to conceptually understand and plan the use of AI technology.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐
Depending on the outline of the thesis, it can be needed to work partly at KTH.

**Contact person**
Niklas Johansson Senior Maintenance Expert
niklas.johansson2@sweco.se

# Intermodal reloading hubs

## SWECO – Transport, Railway

### Background

SWECO is the leading architecture and technical consultant company in Europe with 18 500 employees throughout the continent. Within the railway sector, we have experts in all technical disciplines, e.g. track technology and design, signalling systems and traffic control, electric power system, rolling stock and railway capacity. This degree project proposal is set in the context of the railway capacity and logistics for freight operations. The intermodal freight transport has continuously increased during recent decades. To make the transitions between transport modes, intermodal terminals are used. However, these require a lot of space and are quite time consuming in the reloading sequence.

### Problem description and goals

This degree project seeks to dig deep into the future of intermodal reloading hubs. There are high demands on the effectiveness of logistical capacity and flow of both goods and vehicles. The study should include a solid literature study and discussion regarding the intermodal freight of today and the future, with the focus on the reloading hubs. How is the reloading of goods functioning today and how can it be improved? Depending on outline of the study, simulations with Railsys can be included.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Stefan Bojander
stefan.bojander@sweco.se
Group manager Railway traffic & Logistics

# Motorail traffic in Sweden

## Sweco Sverige AB – Tågtrafik & Logistik (Railway traffic & Logistics)

**Background**
Motorail, where passengers travel in regular passenger coaches while their vehicles are transported on car-transport wagons, could be a solution to manage seasonal peaks in holiday car travel, reduce the environmental impact of holiday trips, and decrease accident risks on the road network. This can be achieved by replacing long-distance car journeys with train journeys, with the car only used for transportation to and from the motorail terminals. Motorail combine the energy efficiency and low emissions per passenger-kilometer of trains with the range, convenience, and flexibility of cars during vacations. Additionally, the long-distance travel can be conducted overnight as a night train.

**Problem description and goals**
A prior thesis researched the possibility to implement motorail traffic in Sweden and there is a lot of research areas to continue researching. A further study could include examining the attitudes of travelers towards and their willingness to travel by motorail, investigating customer demographics and their travel habits, studying operators and infrastructure owners' perspectives on motorail, and investigating financing models for motorail traffic and associated infrastructure. Further studies could also investigate the socio-economic effects of motorail traffic, comparisons with other traffic to determine which should be prioritized in the train planning process, optimal geographic location and design of motorail stations.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Stefan Bojander
stefan.bojander@sweco.se
Group manager Railway traffic & Logistics

# More efficient maintenance planning

## SWECO – Transport, Railway

### Background
Great volumes of freight is transported every day at the Iron ore line in north of Sweden with large financial values. Every year planned maintenance windows on the line affects the possibility to transport freight and as a result have impact on the industries finances.

### Problem description and goals
This thesis proposal focuses on the possibility to find alternative maintenance solutions from a traffic point of view. This may come at a greater maintenance cost but on the contrary generate more value for the industries transporting goods. The methods used could involve timetable construction in RailSys, socioeconomic evaluation and financial analysis.

### Type of degree project (can be both)
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

### Language for the thesis
Swedish:☒ and/or English:☒

### Is Swedish a language requirement?
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

### Possibility to work from our office
Yes:☒
No:☐

### Contact person
Stefan Bojander
stefan.bojander@sweco.se
Group manager, Railway traffic & Logistics

# Effects of prioritising freight operation in timetable construction

## SWECO – Transport, Railway

### Background
Today, the capacity allocation is a complicated process conducted every year to enable a secure and functioning traffic on the rail network. The process involves evaluation of demand and supply in relation to socioeconomic benefits. Due to the different characteristics between freight and passenger traffic in combination with limited available capacity, there will be conflicts and a need to prioritise.

### Problem description and goals
Freight traffic is usually disfavoured and referred to night time operation and long transfer times due to overtakes by faster passenger trains. This thesis proposal focuses on alternatives to the usual capacity allocation. Taking aim in firstly planning for freight traffic and secondly passenger traffic and evaluating its effects. This could be done in the form of case study consisting of a timetable construction in RailSys on a main line or an important goods corridor. Followed by an evaluation of socioeconomic and environmental benefits.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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Group manager, Railway traffic & Logistics

# Strategy for a clock-face timetable for Norrtåg's future service on the line Sundsvall-Luleå

## Sweco Sverige AB – Tågtrafik & Logistik (Railway traffic & Logistics)

**Background**
The operator Norrtåg is designing a strategi for its whole railway system. The large future plan is based on the new line Norrbotniabanan to Luleå which enables travelling along the whole coast line Sundsvall-Umeå-Luleå. Strategically, the focus is that the line should run with a clock-face timetable, where the trains meet at the stations and run at consistent intervals. This enables smooth travelling with connecting public transport in all relationships. It has already been established that a desirable timetable requires new regional trains for 250 km/h.

**Problem description and goals**
It is likely that the design of today's Ådalsbana and Botniabana, as well as the planned Norrbotniabanan, do not provide sufficient capacity and accessibility for an optimal clock-face timetable to be introduced. By analyzing the traffic in Railsys, the aim of this thesis is to identify what deficiencies exist in the infrastructure and preferably also propose what additional infrastructure measures are required to achieve a clock-face timetable for the Norrtåg line with trains at 250 km/h.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Stefan Bojander
Group manager Railway traffic & Logistics
Stefan.bojander@sweco.se

# Vertical track stiffness in the design process

## SWECO – Transport, Railway

### Background

SWECO is the leading architecture and technical consultant company in Europe with 20 000 employees throughout the continent. Within the railway sector, we have experts in all technical disciplines, e.g. track technology and design, signalling systems and traffic control, electric power system, rolling stock and railway capacity. This degree project proposal is set in the context of the railway track system, including both track technology and geotechnical engineering. The vertical track stiffness is a measurement of the elasticity of the track, therefore including all components of the track from rail to subsoil. For this project, it is beneficial if you have a background in either railway track technology and/or geotechnical engineering, as well as having experience with FEM.

### Problem description and goals

In theory, vertical track stiffness is a simple measurement of the elasticity of the track. There are multiple ways to measure it on site at existing tracks. However, it is more difficult to make assumptions for the resulting track stiffness in the design process of a new or renewed track section. This degree project seeks to come closer to an answer on how to apply the governing rules of vertical track stiffness in the design stage. One goal with this project is to get an understanding of the vertical track stiffness and different models of calculating it. A further goal is to evaluate the influence, and how approximate the behaviour, of different components/layers in the track structure and to evaluate different approaches to calculate the track stiffness. In the end, the result should be connected to how the demands of track stiffness could, or should, be handled in the design process.

### Type of degree project (can be both)

Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

### Language for the thesis

Swedish:☒ and/or English:☒

### Is Swedish a language requirement?

Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

### Possibility to work from our office

Yes:☒
No:☒

Depending on the outline of the thesis, it can be needed to work partly at KTH.

### Contact person

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# Optimization of rail vehicle design within asset management framework

## Background

One of the problems in the management of an asset, like a rail vehicle and rolling stock in general, is the lack of alignment and coordination between different entities that contribute during different stages of the asset life cycle. In particular, during the design phase strong emphasis is put in delivering a product according to economic and design requirements without considering other important factors that may influence the future costs and overall success of the asset. At Systra we offer consulting services in the asset management to different stakeholders of the Swedish railway industry such as SJ, Trafikverket, SL, Alstom with focus on realising the best value from their assets.

## Problem description, tasks, and goals

During inspection process of rail vehicles after manufacturing, the design of components and subsystems is controlled in order to grant quality levels in the production according to the requirement of the customer. Among the faults founds some could be avoided in the design phase if the focus is put not only in delivering a product that satisfy the design requirements but also the needs faced along the whole life of the asset (e.g. easy accessibility of key components for maintenance, replacement of parts that may become obsolete etc.). In this context, using available data from an inspection software, you will help us in identifying the possible improvements in the design of the train than can save costs in the future life of the rail vehicle.

Your activities include (but are not limited to):

- Literature review on Asset Management and related digital solutions with focus on the different stages of asset life cycle.
- Define a breakdown structure of the rolling stock asset and understand the functioning of the current inspection software and possible improvements.
- Analyse data from the inspection software (but also other digital AM tools can be included) and identify components and/or subsystems that can be improved.
- Propose a solution for improvements in the rail vehicle with clear motivation (e.g. economic analysis, CAD model, risk assessment etc.)

The skills we look for:

- Railway system: You have a sound knowledge of the railway system (esp. rolling stock) and the various subsystems that comprise it.
- First principles of systems engineering, mechanical & electrical engineering
- Documentation: You can do a thorough literature survey with attention to detail and present your findings in an organized manner. You are comfortable with Swedish documents. You are good in Microsoft Office.
- Willingness to learn: You will go through a steep learning curve and need to be prepared to grasp diverse skillsets such inspection software, maintenance data etc.

- Independent & collaborative: You will need to take the initiative to engage with various people during the assignment.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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# Digital twin architecture of rolling stock with a focus on asset management

## Systra

### Background

One of the main problems faced by the Swedish railway industry is breakdown of rolling stock operations due to various reasons such as obsolete components, changing regulations and legacy methods for asset register, and maintenance crunch amongst others. In Systra we consult for various stakeholders in the Swedish railway industry such as SJ, SL and Alstom, on asset management of rolling stock with an increasing push towards digitalization. Our experience places us at a unique position to cater to the future needs of the rolling stock operators to realise the maximum value from their assets.

### Problem description, tasks, and goals

At Systra we are exploring digital solutions to help us with predictive maintenance of rolling stock and reduce time in identifying and resolving faults in the asset. In this we envision a connected digital eco-system encompassing rolling stock-focussed activities such as inspection at different stages of asset lifecycle, operation, safety assessment, inventory management, vehicle certification etc. A first step in this initiative is building a digital twin architecture of the asset. In this you will help us with the development of the methodology to do so.

Your activities include (but not limited to)

- Perform a literature survey of digital twin applications in the railway sector with a clear focus on asset performance and maintenance
- Define the ontology of a rolling stock asset with clearly-specified causal relationships on the Microsoft Azure platform (See example) . You are also welcome to propose alternative platforms
- Identify various subsystems that make up the asset and work with vehicle documentation to create its digital representation
- For a chosen subsystem, assign/define asset performance indices in the lines of Form, Function, Safety, and System that help is making choices for the asset owner

The skills we look for:

- Railway system: You have a sound knowledge of the railway system (esp. rolling stock) and the various subsystems that comprise it
- First principles of systems engineering, mechanical & electrical engg.
- Documentation: You can do a thorough literature survey with attention to detail and present your findings in an organized manner. You are comfortable with Swedish documents. You are good in Microsoft Office
- Willingness to learn: You will go through a steep learning curve and need to be prepared to grasp diverse skillsets such as Azure platform, inventory management, etc

- Independent & collaborative: You will need to take the initiative to engage with various people during the assignment

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☐
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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# Examensarbete - signalsystemets samverkan med tågskyddsystemet

Utredning av användning av 100 kPa-läget i tågskyddsystemet.

## Uppdragsgivare

Trafikverket – signal styrning, nationell organisation.

## Beskrivning av ämnet

I ombordsystemet ATC finns möjligheten att ställa in en reducerad bromsverkan vid systembromsingrepp till 2/3 retardation. Inställningen ger information till tåget att börja bromsa tidigare och kan användas vid misstanke om låga adhesionsförhållanden. Tågskyddssystemet behöver därför få information från signalsystemet via baliser på ett tillräckligt avstånd relaterat till hastighet och banans lutning. Ett tillräckligt avstånd motsvarar avstånden i normaltabellen TRVINFRA 00302 kap 13. Signalsystemets utformning och dimensionering garanterar inte normaltabellens avstånd idag. Ett arbete med att kunna köra längre godståg i högre hastigheter (LTS-projektet) har även använt marginaler i systemet som tidigare var avsatta för 100 kPa-läget upp till och med hastigheter på 120 km/h.

Benämningen 100 kPa-läget benämns även som ”mjuk övervakning”. Bakgrunden till benämningen är att en fullbromsning motsvarar en trycksänkning av huvudluftledningen med 150 kPa. En reducerad bromsverkan ges om en lägre trycksänkning ges.

## Omfattning

Förslag till examensarbetets frågeställning kan vara

- Kan vi tillåta att köra med inställningen 100 kPa med dagens förutsättningar?
- Vad finns det för risker med att använda 100 kPa läget nu och i framtiden?
- Kan vi ta bort möjligheten att köra med 100 kPa läget och dimensionera signalsystemet utifrån detta?

I examensarbetet ges bland annat möjligheter att

- Kunna delta i ett signalregelverksöversynsprojekt inom interaktion fordon och signalsystem
- Fördjupa sig i tågskyddsystemets funktioner
- Fördjupa sig i tågs bromssystem
- Förstå hur signalsystemet behöver dimensioneras utifrån tågs bromsförmåga
- Göra beräkningar och simuleringar
- Göra bedömningar om trafiksäkerhet utifrån MTO perspektiv, människa teknik organisation
- Påverka framtidens signalregelverk

## Kontaktinformation

elisabeth.skoglund@trafikverket.se
orjan.jonsson@trafikverket.se

## Frågor

För frågor nås kontaktpersonerna på mail.

## Ansökan

Skriv en kort ansökan med en beskrivning av dig själv, din bakgrund och meriter samt varför detta ämne låter intressant.

# Är du vår nyckel till framgång? Bli vår brygga med järnvägsbranchen för framtidens nyckelhantering

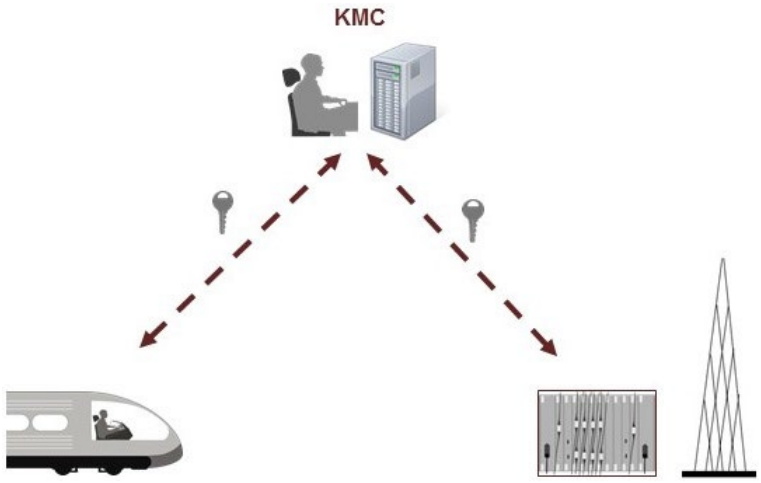
## Trafikverket

### Background

Som infrastrukturförvaltare ämnar Trafikverket att implementera system för en online nyckelhantering. Järnvägen som system behöver alla parter med på tåget för att det ska fungera. Vi behöver din hjälp att överbrygga samarbetet mellan Trafikverket och järnvägsoperatörerna och denna gång med operatörerna i fokus. Syftet med examensarbetet är att sammanställa en rekommendation för operatörerna som verkar i Sverige avseende vägval i implementeringen av online nyckelhantering.

Inom den digitaliserade järnvägen är en säker nyckelhantering ett måste. Genom användandet av kryptering kan mottagaren av informationen verifiera att informationen kommer från rätt avsändare och att den är oförändrad. För att hantera utbytet av nycklar mellan mark- och ombordutrustning och möjliggöra interoperabel järnvägstrafik i Europa finns så kallade Key Management Centre (KMC) som ansvarar för nyckelhanteringen inom och mot andra domäner.

Nyckelhanteringen omfattar generering, lagring, distribution och borttagning av nycklar, se övergripande i Figur 1. Alla mark- och ombordutrustningar måste ingå en sådan domän och vara anslutna till en KMC för sin kryptonyckelhantering.




*Figur 1: Kryptonycklar distribueras från KMC till mark- och ombordutrustning. Notera att Trafikverket endast genererar kryptonycklar till sina egna fordon. Till externa fordon genereras kryptonycklarna via extern KMC.*

Idag används offline nyckelhantering men i Sverige är vi påväg att implementera online nyckelhantering inom de kommande åren. Detta är en förutsättning i takt med att järnvägen digitaliseras och vi behöver din hjälp att få med operatörerna på tåget.

**Problem description, tasks, and goals**
Utreda hur frågan om online nyckelhantering har hanterats av andra infrastrukturförvaltare i Europa/omkringliggande länder. Identifiering av krav för KMC ur ett operatörsperspektiv (subsets, gränssnitt, funktioner). Arkitekturellt övergripande lösningsförslag (subsystemets del i helhet). Identifiering av vägval inkluderat för och nackdelar följt av en rekommendation (utveckla själva, upphandla x, upphandla y..). Output: Generell rekommendation för operatörerna som verkar i Sverige sett till vägval avseende implementering KMC-online

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☐

**Language for the thesis**
Swedish:☒ and/or English:☐

**Is Swedish a language requirement?**
Yes:☒
No: ☐
No, but Swedish is a requirement for future employment:☐

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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**Trafikverket - Alternativa sätt att elektrifiera järnvägstrafik**

https://kth-exjobb.powerappsportals.com/en-US/View-Uppdrag/?id=60cfc773-3b17-ee11-a81c-6045bd9e41a0

# Developing Interactive Macroscopic Timetabling Tool

## WSP

**Background**
WSP is a multinational company with broad experience of traffic and capacity studies within the railway sector.

**Problem description, tasks, and goals**
In the long-term strategic planning process, network assessment and infrastructure capacity planning as well as management could preferably be studied and evaluated with a combination of macroscopic and microscopic approaches. Timetable modelling and simulation tools such as RailSys and OpenTrack are intensively used at WSP. However, these tools are time consuming. To that effect, we would like to develop an interactive macroscopic timetabling tool with programming languages such as Phyton or Java.

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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Email kassaw.bediru.seid@wsp.com

# How would a new level separated crossing at Katrineholm affect delays?

## WSP

**Background**
Trains from many cities for (instance Malmö) towards Stockholm on the Southern Main Line have to cross the southbound track at Katrineholm on the Western Main Line (Gothenburg – Stockholm). WSP is a multinational company with broad experience of traffic and capacity studies within the railway sector.

**Problem description, tasks, and goals**
The goal is to have a new level separated crossing on the Western Main Line at Katrineholm so that crossing movements on the Western Main Line are avoided. How would a new level separated crossing on the Western Main Line at Katrineholm so that crossing movements on the Western Main Line are avoided affect the delays in the system?

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
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# New commuter station at Fågelsta for Östgötapendeln

## WSP

**Background**
The commuter line Östgötapendeln runs between Norrköping – Motala / Norrköping – Tranås. As of today, the commuter line Östgötapendeln does not stop at Fågelsta. WSP is a multinational company with broad experience of traffic and capacity studies within the railway sector.

**Problem description, tasks, and goals**
The goal is to have a commuter station at Fågelsta for the Commuter line Östgötapendeln. How would a new stop at Fågelsta affect the traffic? Would a new stop require some infrastructure measures?

**Type of degree project (can be both)**
Master (20 weeks):☒
Bachelor/Högskoleingenjör (10 weeks): ☒

**Language for the thesis**
Swedish:☒ and/or English:☒

**Is Swedish a language requirement?**
Yes:☐
No: ☒
No, but Swedish is a requirement for future employment:☒

**Possibility to work from our office**
Yes:☒
No:☐

**Contact person**
Emin Kovac Traffic and capacity analyst
emin.kovac@wsp.com